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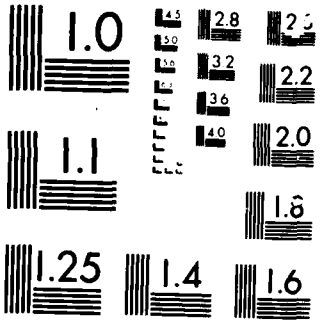

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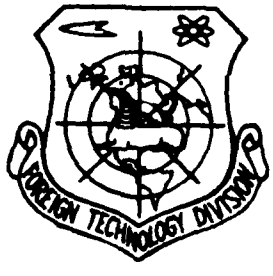
FOREIGN TECHNOLOGY DIVISION

A NEW MATERIAL WITH GREAT PROSPECT -- RAPIDLY SOLIDIFIED MICROCRYSTAL MATERIAL

by

Shi-Xun Zhang



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A NEW MATERIAL WITH GREAT PROSPECT -- RAPIDLY SOLIDIFIED MICROCRYSTAL MATERIAL

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A New Material With Great Prospect --
Rapidly Solidified Microcrystal Material

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Rapidly solidified materials have been developed for the last decade. Due to its excellent properties, this material had gained attention from the scientists and engineers in many countries. Its theoretical basis and practical applications have been under investigation thoroughly and broadly.

The cooling rate of the metal materials which are manufactured in industry by ordinary techniques is about $10^{-2} \sim 10^{2}$ °C/s (The cooling rate of some powder metallurgy can reach $10^{3} \sim 10^{4}$ °C/s). In general, when we say rapid solidification, we mean the cooling rate is higher than 10^{2} °C/s. Right now the cooling rate of the rapidly solidified technique which is often used in foreign countries is in the range of $10^{5} \sim 10^{6}$ °C/s. The products made by this technique include rapidly solidified single- or double-rolled thin plate, ultrasonic foggy powder, rapidly rotating electrode powder, etc. The rapidly solidified materials can be divided into two kinds: amorphous metal material (i.e. metal glass) and microcrystal metal material.

The main characteristics of the rapidly solidified microcrystal material are: (1) It has a very fine and homogeneous structure. When the cooling rate is $10^{5} \sim 10^{6}$ °C/s, the size of the crystal grain is about 0.5 to a few μm. Its partial resolution is very small. The range of the partial resolution, and the distance between each crystal branch arm is about 0.5 ~ 5 μm. As the cooling rate increases, the

crystal grain can be further refined and the partial resolution can be further reduced or even eliminated. Because of the very fine and homogeneous structure, the microcrystal material has very good mechanical properties. Compared with ordinary materials, its strength and ductility, stress and corrosion resistance, fatigue fracture resistance, and high temperature oxidization resistance are much higher. (2) The solid solubility is enhanced remarkably. Due to the high cooling rate, the solid solubility of the rapidly solidified materials can be increased remarkably. Let's take Al alloy as an example. At 934°K, the equilibrious solid solubility of Cu in Al is 0.44%, but it is as high as 17-18% when the rapid solidification technique is employed. Therefore by using this technique, we not only can obtain a high strength material, but more importantly we also can add some metal elements into the metal alloys. These metal alloys which have some special properties can not be obtained by ordinary techniques. If 3～4% of Li, for example, is added into the Al-Cu alloy, its strength and ductility can be enhanced remarkably. However, if this alloy is made by ordinary techniques, it will become brittle because of the existence of Li.

So far there have been some rapidly solidified microcrystal materials which are used practically and experimentally in foreign countries. They are high speed steel, high temperature alloy, stainless steel, and Al alloy. In the process of rapid solidification, the foggy powders or thin plates are usually made first. After that, these powders or thin plates are then pressed into high density materials by the method of thermal-equilibrium-static pressing or thermal pressing.

Since the rapidly solidified materials have such excellent properties, many material scientists believe that the rapid solidification technique could open a new frontier for material science. This new technique will make the development of new alloys and special materials which can not be made by ordinary techniques possible. It should thus have great prospects and high potential.

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